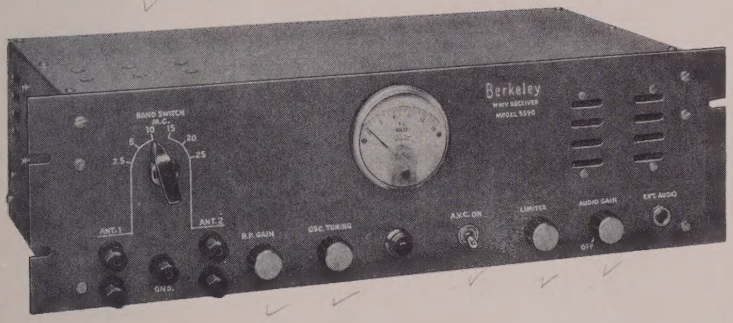
Instruction Manual

MODEL 5590 WWV RECEIVER

Berkeley division
BECKMAN INSTRUMENTS INC.

RICHMOND, CALIFORNIA

DESCRIPTION



GENERAL

The Berkeley Model 5590 WWV Receiver is a 12 tube, dual conversion, superheterodyne receiver specifically designed for optimum reception of the primary standard frequency, time, and tone signals of the National Bureau of Standards' radio stations WWV and WWVH.

Carefully packaged, the Model 5590 is complete in itself with no external tuning mechanisms required. Any one of the six WWV frequencies can be selected by merely turning one front panel switch, insuring foolproof operation.

Meticulous electronic design, including the dual conversion feature, results in extremely good sensitivity, selectivity, and image rejection. A crystal controlled local oscillator is used for maximum I.F. stability. Automatic volume control of the R.F. stage and I.F. stage and a series valve noise limiter insure the best audio reception under adverse conditions. Separate antenna connections for the higher and lower frequencies allow the use of separate antennas for best reception without the necessity of changing antenna leads. A signal strength indicator also indicates the beat frequency between WWV and a local signal for precise frequency matching, while a self contained loudspeaker and an external audio jack are provided for time and tone monitoring.

CIRCUIT

A full description of the circuit is given by Figure 2, a block diagram of the circuit, and Figure 5, a schematic diagram.

CONSTRUCTION

The Model 5590 has been carefully packaged to provide the best combination of convenience and compactness, ruggedness and reliable operation. Adapable for either cabinet or standard relay rack mounting, the Model 5590 is only 5-1/4" high. To minimize detuning effect all controls, including the antenna terminals, have been placed on the front panel and all tuning adjustments made accessible without removing the dust covers. The entire tuning unit and crystal oscillator are isolated in a well shielded sub assembly to prevent interaction with the rest of the circuit. The highest quality components are used throughout the instrument.

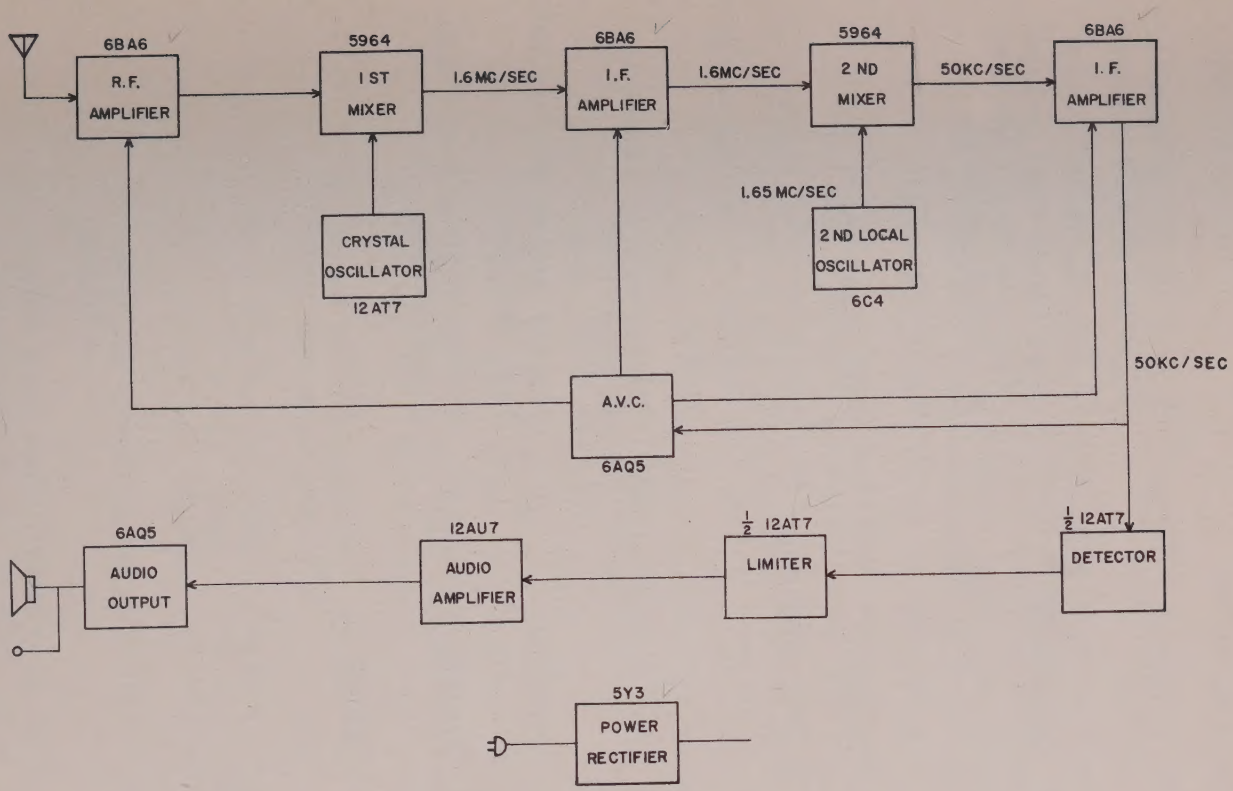


FIGURE 2 BLOCK DIAGRAM

SPECIFICATIONS

Frequency coverage	2.5, 5, 10, 15, 20 and 25 mcs selectable by a front panel switch
Sensitivity	Less than 1 μvolt input required for a 3db ratio of $\frac{\text{signal plus noise}}{\text{noise}}$
Selectivity	1 kc at 3db down
Output	3.2Ω impedance
Tube complement	1-5Y3 2-12AT7 2-6AQ5 1-6C4 1-12AU7 2-5964 or 6J6 3-6BA6
Power requirements	105-130 volts, 50-400 cps, 75 watts
Mounting	Panel or cabinet, standard 19" relay rack size
Outside dimensions	5-7/32" high x 17-1/8" wide x 9-5/16" deep
Weight	17 lbs

OPERATION

INSTALLATION

The Model 5590 needs no special installation. The receiver is designed to fit a standard 19" telephone relay rack.

NOTE: When permanent installation is complete, it will be necessary for best receiver performance to adjust the receiver input coils to match the peculiarities of the antenna being used. AFTER installation of antenna (see antenna paragraph) align the antenna coils ONLY as follows:

1. Place the ouptut leads from any accurately calibrated signal generator near the antenna. Tune the signal generator to 2.5 mcs. Turn the receiver on. Place the Range Switch on the 2.5 mcs position, AVC on R.F. Gain full.

2. Adjust the signal generator output to give an indication on the receiver signal strength meter and tune the receiver oscillator control for maximum signal strength.

3. Adjust C107 ONLY for a peak indication on the signal strength meter reducing the signal generator output as necessary to keep the meter indication on scale. This completes the adjustment for the 2.5 mcs range.

4. Repeat the above procedure for each band. Tune ONLY the control indicated.

2.5 mcs - C107	15 mcs - C104
5 mcs - C106	20 mcs - C103
10 mcs - C105	25 mcs - C102

5. Use a non-conducting screwdriver for all adjustments.

6. When a WWV signal transmission is available it is preferable to use the WWV signal instead of a signal generator for the above procedure.

7. All other adjustments have been made at the factory.

ANTENNA

In the Model 5590, two sets of antenna connections are provided: ANT. 1 for the three lower WWV frequencies and ANT. 2 for the higher. If only one antenna is being used, the antenna leads must be connected to the proper ANT connection for the desired frequency. Either a balanced or an unbalanced antenna may be used. Figure 3 indicates possible antenna arrangements. The type of antenna required for the Model 5590 depends upon the operating conditions. In most cases a short length of wire will suffice. For special installations, refer to any receiver or antenna handbook.

GENERAL

Operation of the Model 5590 has been made extremely simple, since no external tuning units are required. All the operating controls appear on the front panel. To operate, merely plug the line cord into any 105-130V, 50-60 cps line and turn the instrument on by turning the AUDIO GAIN control clockwise. The crystal oscillator is extremely stable after a warm-up period of approximately one minute. Select the desired frequency with the BAND SWITCH. With the AVC switch in the ON position, adjust the OSC. TUNING control for a peak on the meter. The R. F. GAIN control should be turned maximum clockwise and the output level controlled with AUDIO GAIN control. During operation it may be necessary to adjust the OSC. TUNING control occasionally for optimum tuning. The LIMITER control established a threshold beyond which positive signals are suppressed. Therefore, it should be set to a point at which transient noise peaks are eliminated but the audio signal is passed unimpaired. Too much limiter action will distort the output tone. In the event of a very weak signal, the AVC may be switched off and the R. F. GAIN control adjusted for the best signal. The meter is inoperative when the AVC switch is off.

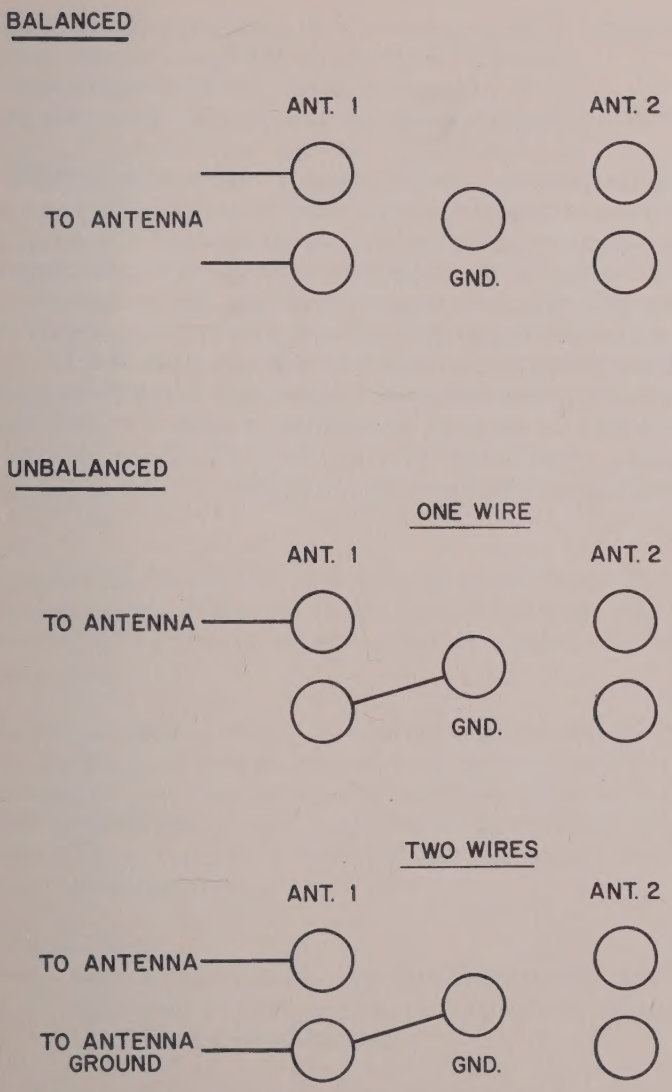


FIGURE 3 ANTENNA CONNECTIONS

FREQUENCY, TIME, AND TONE SIGNALS

NOTE: A description of the frequency and time signal broadcasts of WWV and WWVH can be obtained from the U. S. Department of Commerce, National Bureau of Standards, in their Letter Circular LC 1009.

To compare a local frequency standard with WWV, merely place the lead from the local frequency source close to the antenna connections of the Model 5590 and vary the local source while observing the zero beat on the signal strength meter. The AVC control must be ON during this procedure to activate the meter. Should a very weak signal be the only one available, it can best be heard with the AVC off. With the AVC either on or off, zero beat can be heard through the speaker or through earphones attached to the EXT AUDIO jack. Attaching a plug to the EXT AUDIO jack will automatically disconnect the speaker.

MAINTENANCE

GENERAL

The Model 5590 WWV Receiver has been carefully built to give long, troublefree service and should require little attention aside from occasional tube replacement. The signal strength meter, calibrated in arbitrary units from 0-100, may be re-zeroed by turning the small screw in the meter face while the instrument is off. The receiver has been properly aligned at the factory and should remain aligned for a long time. Before attempting to re-align the receiver, follow the procedures outlined in the TROUBLE-SHOOTING section to make sure the difficulty does not lie elsewhere.

ALIGNMENT

General

This receiver has been carefully aligned at the factory. Re-alignment should be performed only by someone who has had experience with short wave receivers and is qualified to handle such equipment.

An accurately calibrated signal generator (General Radio 1001A or equivalent) and an a-c vacuum tube voltmeter are required for proper alignment. In addition, it is desirable to have an oscilliscope capable of indicating a 25 MC signal (Tektronix 513 or equivalent). Figure 4 indicates the location of all adjustments.

When aligning note:

1. Extreme adjustment of any circuit should not be necessary; one or two turns of the adjusting screw will be sufficient.

2. Use only a non-metallic screwdriver or wrench for minimum capacitance effects.

3. When aligning the entire receiver always proceed in the indicated order.

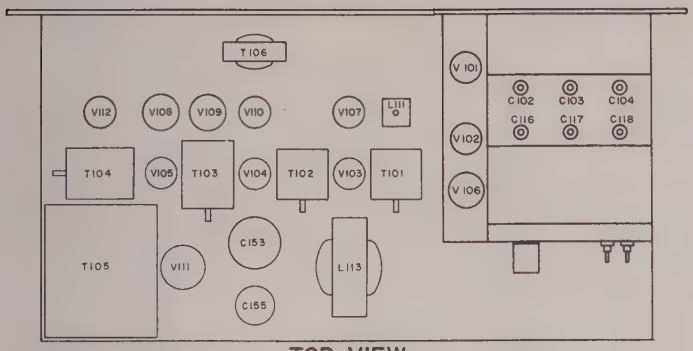
4. Before alignment remove both local oscillator tubes (V106, V107) to prevent interference.

Procedure

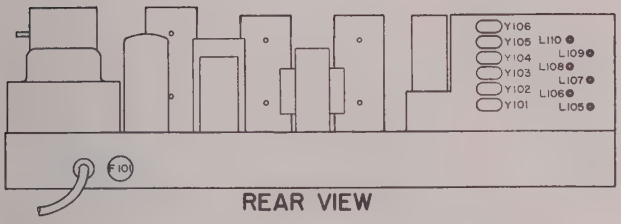
1. SECOND LOW FREQUENCY I.F. TRANSFORMER. Connect all the antenna terminals to the ground terminal. Connect an AC voltmeter between the plate of the audio amplifier tube (pin 6, V109) and the chassis. Tune the signal generator to 50 kcs, 30% modulated with a 400 cps tone and connect the signal generator output through a .01 μf capacitor to the grid of the 2nd I.F. amplifier (pin 1, V105). With enough signal generator output to barely give an indication on the voltmeter adjust one of screws on I.F. transformer T104 for a peak reading on the voltmeter. Then adjust the other screw on T104 for a peak indication, decreasing the signal generator output enough to keep the meter indication on scale. Repeat peaking action with each screw until further adjustment gives no greater reading.

2. FIRST LOW FREQUENCY I.F. TRANSFORMER. Switch the AVC on and attach a d-c vacuum tube voltmeter between the chassis and pin 5, V112 with the positive terminal connected to the chassis and the negative terminal to the tube. This voltmeter will measure the AVC voltage. Keep the signal generator at 50 kcs, modulated as before, and connect the signal generator output through a .01 μf capacitor to the grid of the 2nd mixer (pin 5, V104). With enough signal generator output to barely give an indication on the voltmeter tune T103 in the same manner as T104 above.

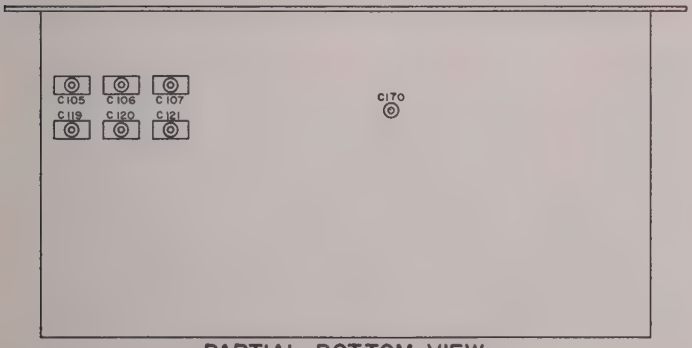
3. SECOND LOCAL OSCILLATOR. Replace V107 to reactivate local oscillator and allow a ten minute warmup. Set the OSC. TUNING control to 1/2 capacity (capacitor plates half meshed). Change the signal generator to 1.6 mcs, 30% modulated by a 400 cycles per second tone, with the generator output still connected to pin 5, V104. Tune the trimmer capacitor C170 for a peak response on the meter. Detune signal generator slightly and check to see that meter peaks at 1.7 mcs also but not at 1.5



TOP VIEW

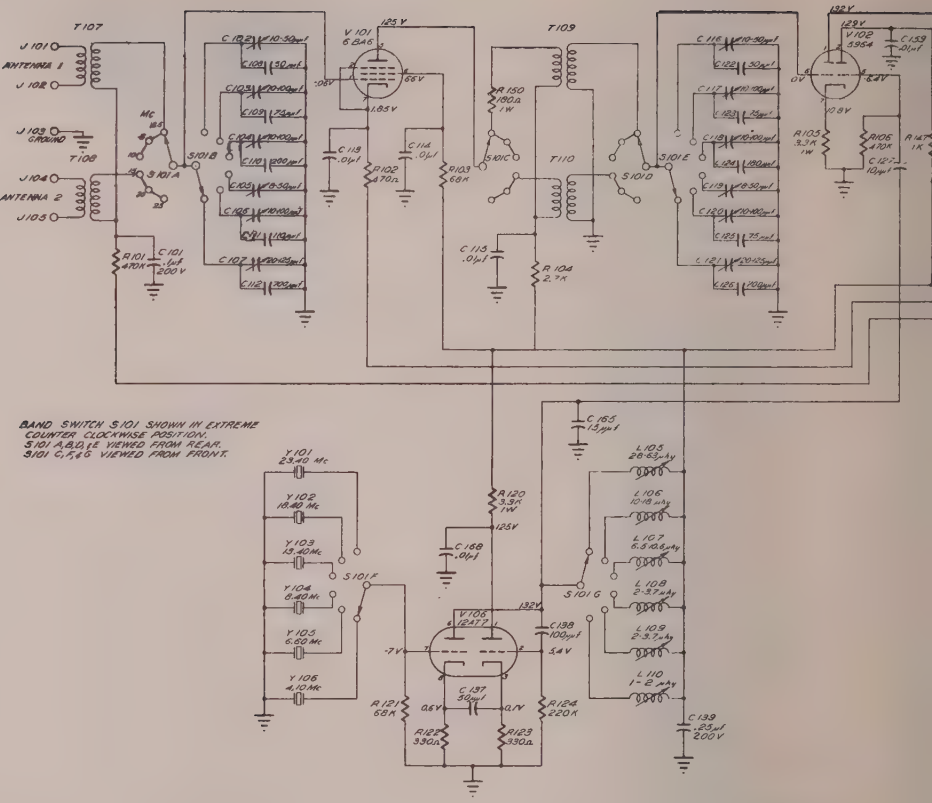


REAR VIEW



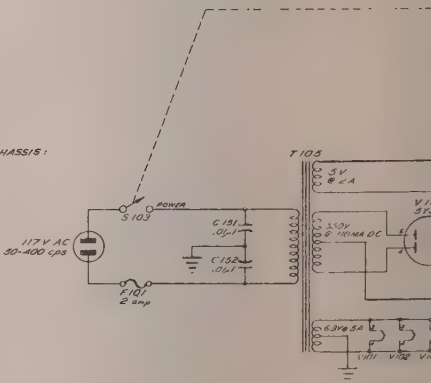
PARTIAL BOTTOM VIEW

FIGURE 4 LOCATION OF ADJUSTMENTS



BAND SWITCH S101 SHOWN IN EXTREME COUNTER CLOCKWISE POSITION.
S101 A,B,D,E VIEWED FROM REAR.
S101 C,F,G VIEWED FROM FRONT.

NOTE:
UNLESS NOTED OTHERWISE ALL RESISTORS ½ W RATING.
UNLESS NOTED OTHERWISE ALL RESISTORS 10% TOLERANCE.
UNLESS NOTED OTHERWISE ALL CAPACITORS 500V RATING.
CONDITIONS OF D.C. VOLTAGE MEASUREMENT WITH RESPECT TO CHASSIS:
1-VTVM 11 MEGOHM INPUT RESISTANCE
2-ANTENNA TERMINALS SHORTED.
3-BAND SWITCH AT 10 Mc.
4-R.F. GAIN AT MAXIMUM (EXTREME CLOCKWISE).
5-OSCILLATOR TRIMMER (C141) AT APPROXIMATELY 50% CAPACITY
6-A.V.C. ON.
7-LIMITER FULLY OFF (CLOCKWISE).
8-AUDIO GAIN EXTREME COUNTERCLOCKWISE.
9-117 V 60cps LINE.



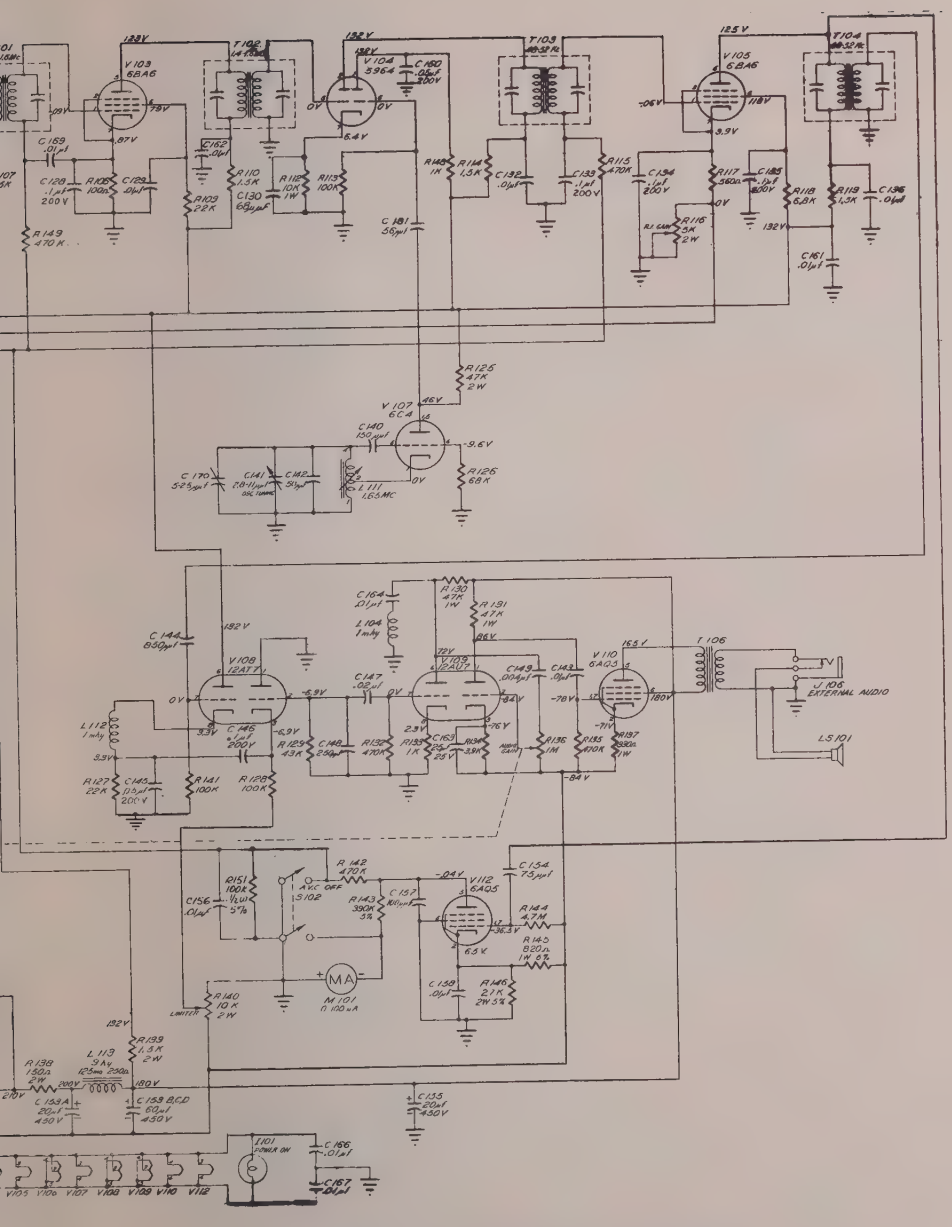


FIGURE 5 SCHEMATIC DIAGRAM

mcs from signal generator; i. e., that the oscillator frequency is 1. 65 mcs and not 1. 55 mcs.

4. HIGH FREQUENCY I. F. TRANSFORMERS. With the signal generator set at 1. 6 mcs as above and connected to pin 1, V103, tune T102 in the same manner as T104. Then connect the signal generator to pin 6, V102 and tune T101 again in the same manner. Remember always to attach the signal generator through a . 01 μf capacitor to the circuit under test. As required, reduce the signal generator output to avoid overdriving the monitoring meter. Occasionally it may be advantageous to adjust the front panel OSC. TUNING control for peak output to compensate for slight oscillator variations.

5. CRYSTAL OSCILLATOR. Align the crystal oscillator as follows:

   Replace the crystal oscillator tube V106. Allow a five minute warm-up. Attach an oscilliscope to the cathode of the first mixer (pin 7, V102) turn the range switch to 2. 5 MC and verify that the crystal oscillator is oscillating at approximately its proper frequency (4. 10 mcs) and that the oscillator wave form is approximately sinosoidal. Tune the oscillator coil (L105) for the peak oscillator output consistant with good wave form. Repeat this step at all oscillator frequencies adjusting the proper coil in each case.

   Frequency is selected with the range switch. The following are the proper frequencies.

Oscillator Coil	Operating Frequency	Oscillator Frequency
L105	2. 5 MC	4. 10 MC
L106	5 MC	6. 60 MC
L107	10 MC	8. 40 MC
L108	15 MC	13. 40 MC
L109	20 MC	18. 40 MC
L110	25 MC	23. 40 MC

If an oscilliscope with the necessary frequency response is not available the oscillator may be tuned for maximum grid bias. With a d-c vacuum tube voltmeter measure negative d-c volts at pin 2, V106 and adjust the oscillator coils for a maximum reading.

6. R-F STAGE. Disconnect the antenna terminals from the ground terminal. Connect the signal generator directly between the ANT. 1 terminals and connect the signal generator chassis terminal to the antenna GND terminal. Set the signal generator at 2.5 mcs and the band switch at 2.5 mcs. Provide sufficient output from the signal generator to give a slight indication on the monitoring voltmeter. Adjust C121 for peak output, lowering the signal generator output as necessary to keep the voltmeter indications on scale. Change the BAND SWITCH, signal generator and antenna and repeat the peaking adjustment for each band according to the following table, following the procedure outlined for the 2.5 mcs band.

Band Switch and Signal Generator Frequency	Adjust	Antenna Connection
2.5 mcs	C121	1
5 mcs	C120	1
10 mcs	C119	1
15 mcs	C118	2
20 mcs	C117	2
25 mcs	C116	2

7. ANTENNA. The antenna trimmers should be adjusted after antenna installation. See installation paragraph in the operation section of this manual.

NOTE: Each R. F. and antenna stage trimmer capacitor must cover the proper range to insure precise alignment. If this is the case there will be two distinct tuning peaks during one 360° rotation of the adjustment screw. If only one peak occurs the capacitor does not cover the range and is being tuned to maximum or minimum capacity rather than to the

proper frequency. In this case, change the value of the associated fixed capacitor (C108-C112, C122-C126, see schematic diagram Figure 5) to shift the trimmer adjustment range.

This completes the alignment of the receiver.

TROUBLESHOOTING

The Model 5590 WWV Receiver has been carefully built to give long, troublefree service. However, after prolonged or abusive use, tubes and other circuit elements may require replacement. If trouble occurs the tubes should be replaced before seeking further difficulty.

When analyzing difficulties in the receiver it is usually valuable to inject a modulated carrier from an accurately calibrated signal generator into the equipment at various points and trace its progress through the sections of the receiver immediately following. Typical voltages in the receiver are listed on the schematic diagram (Figure 5) and voltage measurement at the corresponding points in the receiver may help to localize a difficulty.

When troubleshooting Model 5590, be careful not to distrub the arrangement of components and wiring, particularly in the tuning section. Slight changes in wiring dress may severely detune the receiver.

The following list of possible symptoms and remedies is included as a service aid.

TROUBLESHOOTING CHART

Symptom	Cause
Receiver Inoperative Pilot light out	Blown fuse, shorted element
Receiver Inoperative Pilot light lit No hum or noise through earphones	a) No B plus. Rectifier tube (V111) failure. Filter capacitor breakdown. (C153, C155)

	b) Tube failure
	c) Speaker and/or output jack open or shorted
No signal on all bands. Hum or noise through earphones	a) No input. Antenna terminals shorted
	b) Range switch shorted
	c) Crystal oscillator (V106) inoperative
No signal on one particular band	a) Crystal malfunction
Note: WWVH does not broadcast continuously on all bands. Check broadcast schedule.	b) Range switch malfunction
Meter inoperative or pinned, varying or fading signal	AVC inoperative Tube failure (V112)

PARTS LIST

PRINCIPAL COMPONENTS

Should replacement be necessary, the components listed should be duplicated exactly. These may be obtained from the factory if not locally available. Parts not listed but shown on the schematic are standard and may be replaced by similar components of the same value.

Detail No.	Stock No.	Description
RESISTORS		
R116	1-1343	Potentiometer; 5K, 2W, ±20%, linear, carbon
R136	S1-5267	Potentiometer; 1M, 1/2W, semi-log, carbon with SPST switch
R140	1-0875	Potentiometer; 10K, 2W, ±10%, linear, carbon
CAPACITORS		
C101	2-2583	.1 μf, 200V, metalized paper
C102	S2-5270	10-50 μμf, ceramic trimmer
C103-C104	S2-5271	10-100 μμf, ceramic trimmer
C105	S2-5272	8-50 μμf, ceramic trimmer
C106		Same as C103
C107	2-2196	20-125 μμf, ceramic trimmer
C108	2-2141	50 μμf, ±5%, 500V, mica

Detail No.	Stock No.	Description
CAPACITORS (cont'd)		
C109	2-1706A	75 μμf, ±5%, 500V, mica
C110	2-2611	200 μμf, ±5%, 500V, mica
C111	2-3503	110 μμf, ±5%, 500V, mica
C112	S2-5275	700 μμf, ±5%, 500V, mica
C116		Same as C102
C117-C118		Same as C103
C119		Same as C105
C120		Same as C103
C121		Same as C107
C122		Same as C108
C123		Same as C109
C124	2-3068	180 μμf, ±5%, 500V, mica
C125		Same as C109
C126		Same as C112
C127	2-2082	10 μμf, ±5%, 500V, mica
C128	2-5937	.1 μf, 200V, paper
C130	2-2555	68 μμf, ±5%, 500V, mica
C131	2-2763	56 μμf, ±5%, 500V, mica
C133, 134 & 135		Same as C128

Detail No.	Stock No.	Description
CAPACITORS (cont'd)		
C137		Same as C108
C138	2-2136	100 μμf, ±5%, 500V, mica
C139	2-5938	.25 μf, +20% - 10%, 200V, paper
C140	2-1943A	150 μμf, ±5%, 500V, mica
C141	S2-5841	2.8-11 μμf, variable air, 180° stop
C142		Same as C108
C144	2-2241	850 μμf, ±5%, 500V, mica
C146		Same as C128
C148	2-2142	250 μμf, ±5%, 500V, mica
C149	2-1952	.004 μf, ±40% - 20%, 600V, paper
C153	S2-5746	4 x 20 μf, 450V, electrolytic
C154		Same as C109
C155	2-2112	20 μf, 450V, electrolytic
C157		Same as C138
C163	2-0305	25 μf, 25V, electrolytic
C165	2-2135	15 μμf, ±5%, 500V, mica
C170	2-2326	5 - 25 μμf, ceramic trimmer

Detail No.	Stock No.	Description
INDUCTORS		
L104	3-3559	1 mh, ferrite core, axial leads
L105	S3-5283	28-63 μh, slug tuned coil
L106	S3-5284	10-18 μh, slug tuned coil
L107	S3-5285	6.5 - 10.6 μh, slug tuned coil
L108-L109	S3-5286	2 - 3.7 μh, slug tuned coil
L110	S3-5287	1 - 2 μh, slug tuned coil
L111	S3-5282	1.65 mcs oscillator coil
L112		Same as L104
L113	S3-5288	9 hy, 125 ma, 250Ω dc choke
TRANSFORMERS		
T101-T102	S6-5289	1.4 - 1.6 mcs I.F.
T103-T104	S6-5290	48 - 52 kcs I.F.
T105	S6-5292	Power. primary:117V secondaries: 550V C.T. 110 ma. dc; 5V, 2 amps; 6.3V, 5 amps
T106	S6-5291	Audio, 5000Ω impedance, 40 ma, 3W
T107	S6-5278	Antenna coil
T108	S6-5279	Antenna coil

Detail No.	Stock No.	Description
TRANSFORMERS (cont'd)		
T109	S6-5280	RF coil
T110	S6-5281	RF coil
CRYSTALS		
Y101	S13-5299	23.40 mcs, HC 6/U holder
Y102	S13-5298	18.40 mcs, HC 6/U holder
Y103	S13-5297	13.40 mcs, HC 6/U holder
Y104	S13-5296	8.40 mcs, HC 6/U holder
Y105	S13-5295	6.60 mcs, HC 6/U holder
Y106	S13-5294	4.10 mcs, HC 6/U holder
MISCELLANEOUS		
M101	S15-5300	Meter, 100 μamp full-scale
LS101	S27-5301	Speaker, 3.2 Ω voice coil, 2"
S101	S12-5635	Switch, 6 position 4 section rotary
XY101 to 106	S4-5293	Crystal socket, ceramic, .487 spacing
J101, 102 104, 105	17-3645	Binding post, red, five way

Detail No.	Stock No.	Description
MISCELLANEOUS (cont'd)		
J103	17-3646	Binding post, black, five way
	S24-3652	Knob, 3/4", vinylgrip
	24-5659	Knob, 1-1/4" bar, polished
	S24-5661	Handle, brass, nickel plated

WARRANTY

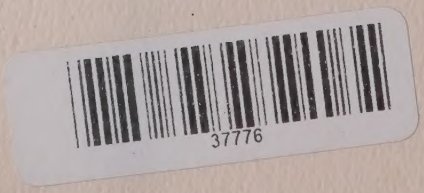
Every instrument manufactured by the BERKELEY division of Beckman Instruments, Inc. is warranted to be free from defects in material and workmanship. Our obligation under this warranty is limited to repairing or replacing any instrument or part thereof, except tubes, which shall within one year from date of shipment to the original purchaser prove to be defective after our examination.

Instruments to be repaired must be returned to the factory with transportation charges prepaid. Repair work will be performed only upon receipt of a written purchase order or authorization.

Claims for damage in shipment should be filed promptly with the transportation company. All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate.

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing.

Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, BERKELEY division of Beckman Instruments, Inc., Richmond 4, California.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